BOVINE REPEAT CESAREANS AS A GENETIC AND EMBRYOLOGICAL RESEARCH TOOL

by

JOHN LEROY NOORDSY

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D.V.M., Kansas State University, 1946

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INTRODUCTION

Cesarean section is the procedure by which a fetus is delivered from its dam through an incision in her abdominal and uterine wall.

Terminal pregnancy cesareans are common today in both human and animal medicine. With the present technique, equipment, and medications available, the modern day surgeon does not hesitate to undertake a cesarean section.

Teratology, the study of anomalies, has long been an interesting and fascinating subject for many investigators. The study of bovine teratology extends back several decades, but it has been limited by the somewhat lengthy gestation period of the bovine. Under normal gestation, only one calf per year can be obtained.

The purpose of this study was to attempt a method which might speed the study of teratology in the bovine by the use of cesareans at stages earlier than terminal gestation.

Syndactylism, otherwise known as "single-toe" or "mule-foot" was the particular anomaly of concern in this project. Other anomalies, including brachygnathism, also termed "parrot-jaw", blindness, microphthalmus, and anouria (taillessness) were present in the genetic background of five of the surgical subjects, but they were of less concern than syndactylism.

Syndactylism may be observed in the developing embryo quite readily as early as forty days post conception.

With the knowledge that embryos in the thirty to forty day period of gestation could be used for genetic and embryological study, a method of early recovery of such an embryo was desired. Thus, cesarean section with surgical removal of the developing embryo from the pregnant uterine horn was attempted.

It was hypothesized that under controlled conditions a particular bovine female would be able to produce several embryos per year as compared to the expected one calf per year under normal gestation and delivery.

Total and differential leukocyte counts were to be used as an index of reaction to the surgical procedure.

REVIEW OF LITERATURE

Surgery

The surgical procedure of cesarean sections in humans dates back many years. Roman law prescribed that every woman dying in advanced pregnancy should be so treated. Legend has it that Julius Caesar was born by this method. Apparently this is erroneous, but nevertheless, surgery of this type is legendary with his name (Roberts, 1956).

According to Wright (1951), one of the first reported successful cesareans performed on a woman was accomplished by her husband who was a Swiss pig "gelder". Apparently, knowledge gained from pigs enabled him to successfully perform the surgery and have the mother live.

John Field (Wright, 1951) in 1839 and J. B. Carlisle (Wright, 1951) in 1840 refer to successful operations on the bitch and sow respectively. Although suturing of the incision is standard procedure today, it was interesting to note that Carlisle did not suture either the uterus or the abdominal wall. The abdominal wall was kept in apposition by the use of strong "adhesives".

All of the early recorded cesareans were performed on terminal pregnancy cases without anesthesia, which at that time was an undiscovered science.

References to successful bovine cesareans date back to 1840, but the operation did not become popular until the 1940 era. Frank and Roberts (1940) describe the operative procedure for successful cesareans in the bovine. Roberts and Frank (1942), Benesch and Wright (1951), and Wright (1953) refer to successful bovine cesareans.

Williams (1943) writing about terminal pregnancy cesarean sections in the bovine, doubted the expediency of the operation. He based his opinion primarily on the commercial value of the cow as related to the expected survival rate following surgery. He expressed an opinion that only 35 to 50 percent of the patients survived. Williams concluded, "It is generally impolitic to attempt to rebreed uniparous females after apparent recovery following cesarean section."

Reports by Roberts and Frank (1942) on 58 cases, indicated an expected 78 percent maternal recovery. Oberst and Frank (1954) reported on cases from Kansas State University and suggested less than 5 percent mortality could be anticipated if the cow was in good surgical condition.

Thus, with advances in medical knowledge and surgical technique, the operation on terminal pregnancies has become common among veterinarians.

Literature on cesarean sections in the bovine is primarily concerned with terminal pregnancy except for the infrequent emergency where impending death of the mother was anticipated during the last two months of gestation.

Repeat terminal pregnancy cesareans are common in women and female dogs, but literature on repeat cesareans in the bovine is lacking.

MATERIALS AND METHODS

Experimental Animals

Twelve cows of varying genetic background, reproductive history, age and breed were selected. These cattle were obtained from various sections of the country for genetic study of congenital anomalies. No effort was made to obtain animals that would be considered ideal surgical subjects.

Five of the twelve were virgin Holstein heifers that exhibited physical evidence of syndactylism in varying degrees. They were numbered 56B, 57B, 58B, 60B, and 82B.

The remaining seven included numbers 30B and 77B which were syndactylous carrier Holstein females; 80B, a congenitally bilateral microophthalmic Holstein; 35B, a congenitally blind Brown Swiss; 49B, a normal appearing daughter of an anouria dam; 54B, a normal appearing twin from an anouria dam (49B and 54B had the same dam); and 55B, a Guernsey-Jersey cross from a brachygnathic sire. Number 54B and 49B had Angus ancestry.

Three of the nonsyndactylous females were known to have delivered one or two calves; these were numbers 30B, 35B, and 49B. Numbers 54B, 55B, 77B, and 80B were virgin heifers.

Number 30B, 35B, 49B, 54B, 55B, 77B, and 80B were females that did not exhibit syndactylism and were referred to as nonsyndactylous.

All of the cattle were kept in drylot in one group and were fed a nutritionally adequate dairy ration.

Breeding of the cattle was primarily by natural service, but in certain instances, artificial insemination was used to obtain a desired genetic background.

Breeding records were kept on each female. Visual evidence of estrum prompted the caretaker to place the female with the male in separate breeding areas.

Approximately one week following the female's first indication of pregnancy, as evidenced by failure of signs of estrum, each cow was examined per rectum. If pregnancy was confirmed, surgery was scheduled.

Withdrawal of feed, whenever possible, for twenty-four hours prior to surgery was used to facilitate the operation. Each female was transferred from the regular holding area to the Dykstra Veterinary Hospital for surgery.

Collection of Blood

Approximately five ml. of blood was collected from the middle coccygeal vein into a syringe containing ethylenediaminetetracetate[1] as the anticoagulant. This collection was made immediately prior to surgery and at twenty-four hour intervals following surgery. The blood was then transferred to the Veterinary Diagnostic Laboratory for examination.

Body Temperature

Rectal temperatures were taken immediately prior to surgery and at twenty-four hour intervals following surgery.

Surgical Procedure

The patient was confined in a cattle chute in a standing position. In

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[1] "Sequester-Sol"; Cambridge Chemical Products, Inc., Dearborn, Michigan.

a highly nervous subject, five ml. of chlorpromazine hydrochloride[1] was injected intravenously for tranquilization.

Normal surgical preparation included clipping the operative area with a #40 blade on a small animal clipper, scrubbing once with soap and water, rinsing well and then scrubbing three times with a germicidal detergent[2] solution. The first surgical operations were all performed on the left side.

Local nerve blocking was obtained by the infiltration of approximately fifty ml. of 2 percent lidocaine hydrochloride[3] into the tissue to be incised. An alcoholic quaterinary ammonium compound[4] was applied to the surgical area.

Sterile gloves, including a shoulder length glove on the left arm, were used by the surgeon.

The entire paralumbar area was draped with sterile cloth. A five inch incision was made through the skin, musculature, and peritoneum. First incisions were made, beginning anterior to the tuber coxae and ventral to the lateral processes of the fourth and fifth lumbar vertebrae and extending ventrally approximately five inches. Each succeeding operation incision was spaced approximately one-half inch anterior and parallel to the previous incision. Minor hemorrhage was controlled by temporary pressure packs.

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[1] "Thorazine"; Pitman-Moore Co., Indianapolis, Indiana.
[2] "pHisoHex"; Winthrop Laboratories, New York, N. Y.
[3] "Xylocaine"; (Astra) Jen-Sal Laboratories, Inc., Kansas City, Missouri.
[4] "Roccal"; Winthrop Laboratories, Inc., New York, N. Y.

The left hand was inserted into the peritoneal cavity through the paralumbar incision and the pregnant uterine horn located. A twenty inch uterine forceps was inserted through the incision along the flexor side of the previously inserted arm. The pregnant horn was grasped dorsal or posterior to the embryo and just below the uterine bifurcation. With gentle traction on the forceps and manipulation with the left hand, the pregnant horn was extended forward to present it in the paralumbar incision. With an assistant holding the uterine forceps, the surgeon's right hand was free to incise the uterine horn. An incision approximately one inch in length was made over the embryo, through the serosa, myometrium, and endometrium. This exposed the amnionic vesicle. By applying gentle pressure on the uterine horn from the medial side with the fingers of the left hand, the embryo was expressed through the uterine incision.

Following the harvest of the embryo, an attempt was made to remove the placental membranes. In no case were the membranes left protruding through the uterine incision.

Thirty ml. of a 0.2 percent solution of nitrofurazone[1] was then infused into the incised uterine horn.

The uterine horn incision was closed with one row of an inverted "Cushing" suture of #2 chromic catgut in nine of the first twelve operations. Uterine incisions on 80B, 77B, and 82B were not sutured following the first incision. Cows 49B, 54B, 55B, 58B, and 60B were involved

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[1] "Furacin"; Eaton Laboratories, Norwich, New York.

in suturing of the second uterine horn incisions, but thereafter, the uterine horn was sutured only if the fetus removed was more than sixty days of age or in the case of an accidental tear in the uterine wall.

The uterine forceps was released and the uterus replaced in its natural position.

No attempt was made to remove the corpus luteum at the time of surgery.

A mixture of 500 ml. of normal saline solution and two grams of oxytetracycline or chlortetracycline activity was placed in the peritoneal cavity. Ten ml. of penicillin-streptomycin mixture were administered intramuscularly.

The peritoneum was sutured with a continuous suture of #2 chromic catgut. The muscle layers were sutured with one continuous row of #2 chromic catgut and the skin sutured with one-eighth inch umbilical tape, using a blanket or continuous lock type stitch.

Postoperative Care

Patients were then placed in individual stalls in the clinic and held for two to three days. No attempt was made to withhold feed following surgery.

Blood samples were collected and temperatures were recorded at twenty-four hour intervals.

No additional medication was administered.

Skin sutures were removed ten to fourteen days following surgery.

RESULTS AND DISCUSSION

Total Number of Operations per Animal

A total of thirty-four operations were performed on twelve cows during the first cow-year.[1] Additional operations were performed on 30B, 49B, and 54B after the first cow-year. Cow 30B had a total of six cesareans in a period of slightly over nineteen months. Cow 49B had five cesareans in a period of approximately sixteen months, while 54B had five cesareans in a period of approximately twelve months. Cows 30B, 49B, and 54B were all nonsyndactylous females.

Table 1. Summary of embryos or fetuses obtained by genetic cesarean section for the first cow-year.

Nonsyndactylous (7)		Syndactylous (5)	
Cow No.	Embryos or Fetuses	Cow No.	Embryos or Fetuses
30B	4*	56B	2
35B	3	58B	2
49B	4**	60B	1
54B	4***	77B	2
57B	4	82B	2
57B	4		
80B	3		
Total	25		9
AVERAGE	3.57		1.8

*Two additional embryos during second-year.
**One additional embryo during second-year.
***One additional embryo during second-year.

[1] A cow-year is measured from the time of conception, or approximately forty days prior to the first cesarean and extending to the same date the following year.

With reference to Table 1, the fact that the seven nonsyndactylous females averaged 3.57 embryos per year as compared to 1.8 for the syndactylous was somewhat anticipated. Research by Huston (1961) indicated the natural breeding history of syndactylous cattle to include possibly only one offspring. His work indicated that in nineteen animals studied, seven did not live long enough to produce offspring and the average number of offspring born per female was one. No syndactylous animals succumbed in this project.

Case Histories of Individual Cows

Table 2. Summary of individual genetic cesarean sections on syndactylous "carrier" 30B (born 11/22/56; calved normally 4/20/59).

1: Op.:	Date	:Skin 2 In. Loc.	3 Preg.	4 Ut. Horn	Age of Fet. Em.	Remarks
1	6/30/60	L.P.F.	Yes	?[5]	228 day	Normal surgical procedure. Uterine horn sutured.
2	12/29/60	"	"	Left	39 "	Normal surgical procedure. No periuterine adhesions. No uterine horn sutures.
3	3/15/61	"	"	Right	39 "	Uterine horn torn--sutured. No periuterine adhesions.
4	6/7/61	"	"	"	31 "	Normal surgical procedure. Slight periuterine adhesions. No uterine horn sutures.
5	8/18/61	"	"	"	40 "	Normal surgical procedure. Moderate periuterine adhesions. No uterine horn sutures.
6	1/13/61	"	"	"	44 "	Normal surgical procedure. Considerable omental and periuterine adhesions. No uterine horn sutures.

[1]Operation number.

[2]Skin incision location; i.e.; "R.P.F." = right paralumbar fossa; "L.P.F." = left paralumbar fossa.

[3]Indicates pregnancy or non-pregnancy.

[4]Indicates which uterine horn was pregnant.

[5]No record of which uterine horn was pregnant.

Table 3. Summary of individual genetic cesarean sections on nonsyndactylous 49B (born 9/22/58; one previous calving).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	12/22/60	L.P.F.	Yes	Left	41 day	Normal surgical procedure. Uterine horn sutured.
2	3/1/61	"	"	Right	39 "	Normal surgical procedure. Uterine horn sutured.
3	8/12/61	"	"	"	33 "	Normal surgical procedure. Uterine horn not sutured.
4	10/25/61	"	"	"	41 "	Normal surgical procedure. Uterus not sutured.
5	4/2/62	"	"	Left	37 "	Normal surgical procedure. Slight periuterine adhesions. Uterine horn not sutured.

Table 4. Summary of individual genetic cesarean sections on nonsyndactylous 54B (born 12/29/58; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	12/29/60	L.P.F.	Yes	Right	75 day	Normal surgical procedure. Uterine horn sutured. COW VERY OBESE.
2	4/22/61	"	"	Left	79 "	Considerable periuterine and omental adhesions. Uterine horn sutured.
3	7/8/61	"	"	"	37 "	Extensive periuterine and omental adhesions. Uterine horn not sutured.
4	9/22/61	R.P.F.	"	Right	40 "	Extensive periuterine adhesions. Uterine horn not sutured.
5	12/2/61	"	"	"	39 "	Embryo not recovered due to extensive adhesions. COW SLAUGHTERED 12/21/61.*

*No additional pathology noted at slaughter. Cow was extremely obese in pelvic area.

Table 5. Summary of individual genetic cesarean sections on nonsyndactylous 55B (born 2/6/59; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	8/1/60	L.P.F.	Yes	Left	53 day	Normal surgical procedure. Uterine horn sutured.
2	11/18/60	"	"	Right	60 "	Normal surgical procedure. Uterine horn sutured.
3	1/25/61	"	"	Left	31 "	Normal surgical procedure. Uterine horn not sutured.
4	2/6/62	"	"	Right	134 "	Considerable omental and peri-uterine adhesions. Uterine horn sutured.

Table 6. Summary of individual genetic cesarean sections on syndactylous 57B (born 4/1/59; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	10/8/60	L.P.F.	Yes	Right	42 day	Normal surgical procedure. Uterine horn sutured.
2	1/17/61	"	No	-	- -	Uterine horn incised. Uterine horn not sutured.
3	4/24/61	"	Yes	Left	55 day	Normal surgical procedure. Uterine horn not sutured.
4	8/25/61	"	"	Right	38 "	Normal surgical procedure. Fetal membranes present--NO EMBRYO RECOVERED. Uterine horn not sutured. SLAUGHTERED 3/27/62.*

*No extensive gross pathology noted.

Table 7. Summary of individual genetic cesarean sections on nonsyndactylous 35B (born 6/10/57; calved normally 2/3/60).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	9/9/60	L.P.F.	Yes	Left	51 day	Normal surgical procedure. Uterine horn sutured.
2	1/4/61	"	"	Right	75 "	Normal surgical procedure. Uterine horn not sutured.
3	5/19/61	"	"	Left	35 "	Normal surgical procedure. Uterine horn not sutured. SLAUGHTERED 10/24/61* "N.G.L." reactor to T.B.

*No gross uterine pathology noted.

Table 8. Summary of individual genetic cesarean sections on nonsyndactylous 80B (born 4/1/60; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	5/3/61	L.P.F.	Yes	Right	31 day	Normal surgical procedure. Uterine horn not sutured.
2	7/12/61	"	"	Left	33 "	Uterine horn torn--not sutured. EMBRYO APPARENTLY LOST IN PERITONEAL CAVITY.
3	2/7/62	"	"	Left	46 "	Normal surgical procedure. Considerable periuterine adhesions. Uterine horn not sutured.

Table 9. Summary of individual genetic cesarean sections on syndactylous 56B (born 1/23/59; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	9/29/60	L.P.F.	Yes	Left	41 day	Normal surgical procedure. Uterine horn sutured.
2	7/6/61	"	"	"	41 "	Normal surgical procedure. Uterine horn not sutured.
3	2/8/62	"	"	Right	37 "	Normal surgical procedure. Uterine horn not sutured.

Table 10. Summary of individual genetic cesarean sections on syndactylous "carrier" 77B (born 4/4/60; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	4/25/61	L.P.F.	Yes	Right	37 day	Normal surgical procedure. Uterine horn not sutured.
2	7/6/61	"	"	Left	39 "	Normal surgical procedure. Uterine horn not sutured. SLAUGHTERED 10/24/61.* "N.G.L." reactor to T.B.

*No gross uterine pathology noted.

Table 11. Summary of individual genetic cesarean sections on syndactylous 82B (born 5/13/60; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	8/18/61	L.P.F.	Yes	Left	33 day	Normal surgical procedure. Only one functional uterine horn (left). Uterine horn not sutured.
2	12/22/61	"	"	"	47 "	Normal surgical procedure. Uterine horn not sutured.

Table 12. Summary of individual genetic cesarean sections on syndactylous 60B (born 5/22/59; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	2/22/61	L.P.F.	Yes	Right	41 day	Normal surgical procedure. Uterine horn sutured.
2	5/3/61	"	"	Left	35 "	Normal surgical procedure. Uterine horn sutured. Fetal membranes present--APPARENTLY NO EMBRYO.

Table 13. Summary of individual genetic cesarean sections on syndactylous 58B (born 4/20/59; no previous calving history).

Op.	Date	Skin In. Loc.	Preg.	Ut. Horn	Age of Fet. or Em.	Remarks
1	12/22/60	L.P.F.	Yes	Right	45 day	Normal surgical procedure. Uterine horn sutured.
2	3/23/61	"	"	Left	39 "	Normal surgical procedure. Uterine horn sutured.
						SLAUGHTERED 3/27/62.*

*No gross pathology of the uterus noted.

Postoperative Adhesions

The major difficulty encountered surgically in the repeat operations was omental adhesions. In general, it appeared that these adhesions might be associated with the general obesity of the female, accumulation of adipose tissue in the pelvic region, and possibly the suturing of the uterine horn with chromic catgut. Work by Tyagi and Lumb (1961) concerning uterine healing in goats indicated that tissue reaction to chromic catgut had a relationship to omental adhesions. Normal surgical procedure in the first round of operations, except for operations on 80B, 77B, and 82B, included suturing of the uterine horn incision with #2 chromic catgut. The small number of animals concerned and the lack of adequate controls hindered any conclusions on this point.

Omental and periuterine adhesions developed in four of the twelve cows. Cow 30B apparently developed uterine adhesions following the accidental tearing of the uterine horn in operation number three. She later produced three additional embryos in spite of the adhesions which become more extensive in each succeeding operation. Cow 54B developed adhesions following the first

surgery. She was a rather obese cow and had large amounts of adipose tissue in the pelvic region. Despite the increase in severity of adhesions in each succeeding operation, she was able to produce four additional embryos. Cow 80B developed adhesions following accidental tearing of the uterine horn during the second operation. Cow 55B did not develop adhesions until after the third operation. Roberts (1956) suggests that infertility may be related to adhesions. It would appear that the adhesions noted in these females might interfere with advanced pregnancy.

Uterine Size and Ease of Operation

Some difficulty was encountered during surgery in extending the uterine horn forward to the paralumbar incision. This apparently was directly related to the length of the uterine horns. Females that had previous calving histories usually had longer uterine horns and were more easily manipulated.

Omental adhesions also limited extending the uterine horn.

Paralumbar Tissue Reaction

Tissue reaction in the paralumbar region appeared to be an additional limitation to repeat operations. With each succeeding operation, tissue reaction tended to increase. Vascularity, although never a serious problem, tended to increase also. With this in mind, it was felt that perhaps four successive operations on either the right or left paralumbar site would constitute a limitation, however, 30B had five successive operations in the left paralumbar region. Because of the possibility that this reaction was due to the type of suture material used, the more recent incisions have been sutured with mersilene polyester fibers.[1]

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[1] "Mersilen", Ethicon, Inc., Somerville, New Jersey.

Uterine Scar Tissue Formation

Observation of the uterine horns from cows that were slaughtered for various reasons after the project year, showed that considerable scar tissue in the serosa and possibly the myometrium existed. It is suggested that this may be the result of the trauma from the use of the uterine forceps.

Incision scars on uterine horns from cows 54B, 57B, 35B, 77B, and 58B were extremely difficult to discern. Scars related to uterine suturing were more evident than those not sutured.

Gross examination of the uterine horns from the slaughtered subjects failed to show evidence of severe endometrial damage. No histological examinations were made.

Postoperative Breeding Interval

A definite measure of the success of the project was the interval needed for conception following surgery. In normal terminal pregnancy, the cow is often bred back in sixty days, but these females were bred at the first estrum after twenty days following surgery.

Table 14 indicates the postoperative breeding interval of the seven nonsyndactylous females. The interval between the first and second operation averaged forty-three days. It would appear that with each succeeding operation, a slightly longer period would be needed for conception to take place. There is an exception, which is unexplainable, in that interval between the fourth and fifth operations of the three cows averaged only thirty-three days. The small number of operations may be the explanation for this.

Table 14. Average postoperative breeding interval of the seven nonsyndactylous females.

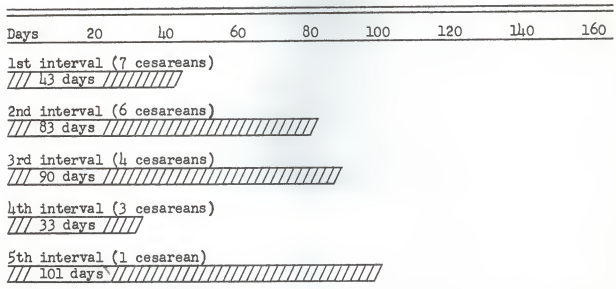


Table 15 indicates the postoperative breeding interval of the five syndactylous females. Fewer operations are reported in this table as compared to Table 14 and only two breeding interval averages are recorded. It should be noted that the five syndactylous females required considerable more time for conception than the seven nonsyndactylous. It would also appear that the time needed for conception following surgery increases with each operation as is true with the nonsyndactylous.

Of considerable interest is the fact that all of the five syndactylous females produced embryos following the second cesarean section. This is in contrast to the average number of calves which may be expected from a snydactylous female, (Huston, 1961).

Table 15. Average postoperative breeding interval of the five syndactylous females.

Postoperative breeding intervals on individual females 30B, 49B, and 54B that are nonsyndactylous and females 56B, 57B, 58B, 60B, and 82B that are syndactylous are indicated in Tables 16 through 23 respectively.

Table 16. Postoperative breeding intervals of 30B.

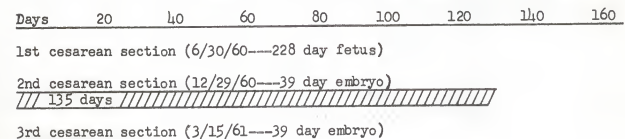


Table 17. Postoperative breeding intervals of 49B.

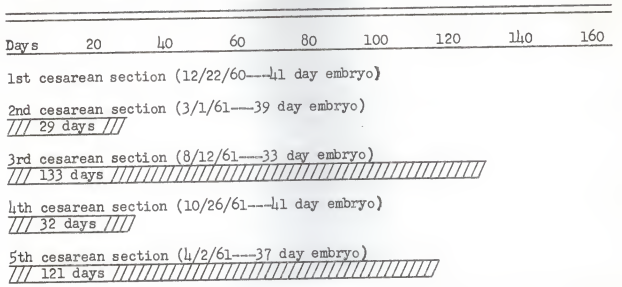


Table 18. Postoperative breeding intervals of 54B.

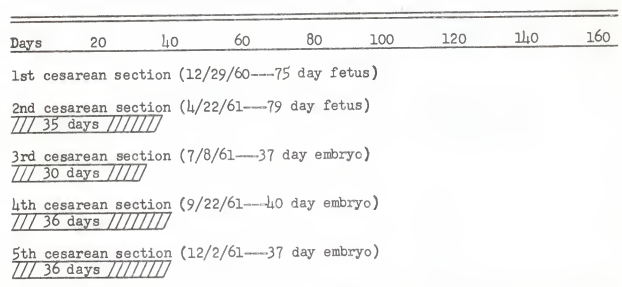


Table 19. Postoperative breeding intervals of syndactylous female 56B.

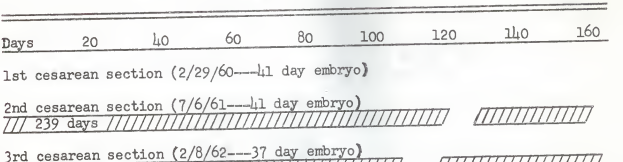
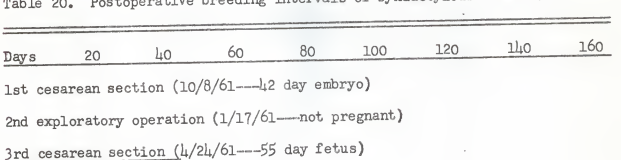


Table 20. Postoperative breeding intervals of syndactylous female 57B.



The fourth operation on 57B (Table 20) would suggest possible early embryonic mortality. This might also be true of the second operation on 57B in which pregnancy was not diagnosed correctly.

Table 21. Postoperative breeding interval of syndactylous female 58B.

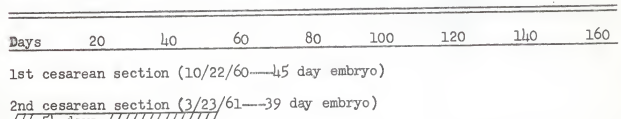


Table 22. Postoperative breeding interval of syndactylous female 60B.

Days	20	40	60	80	100	120	140	160
1st cesarean section (12/22/60---41 day embryo)								
2nd cesarean section (5/3/61---35 day pregnancy; fetal membranes--no fetus) /// 97 days ////////////////////////////*								

*Similar phenomenon as observed in fourth cesarean on 57B (Table 20).

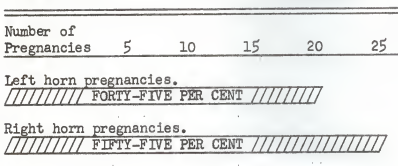
Table 23. Postoperative breeding interval of syndactylous female 82B.

Days	20	40	60	80	100	120	140	160
1st cesarean section (8/18/61---33 day embryo)								
2nd cesarean section (12/22/61---47 day fetus) /// 79 days ////////////////////////								

Pregnancy Site

The incidence of right vs. left horn pregnancies is summarized in Table 24. It should be noted that additional operations which were not included in the first cow-year are used in this summary. These are from operations performed at a later date on additional cows and are included to obtain as high a total number as possible. This particular comparison was incidental to the major aim of the project, but it was included for comparison with work published by Erdheim (1942). He notes a two to one difference between right and left horn pregnancies in favor of the right horn. This survey was made on 1,506 dairy cows. A similar survey by Erdheim (1942) on 2,318 beef cows indicated almost an equal number of right and left horn pregnancies.

Table 24. Comparison of right vs. left horn pregnancies.*



*Does not include two pregnancies of 82B--only one functional horn.

Unicornate Uterus

Another interesting sidelight of the project was the inclusion of cow 82B which had only one functional uterine horn. According to Perkins et al. (1954), single-horned uteri were found in 0.4 percent of 444 heifers studied or 0.2 percent of a total of 1000 mature cows studied.

In spite of this condition, 82B produced three embryos in approximately nine months, which corresponds very closely to the overall average of the nonsyndactylous females.

Total and Differential Leukocyte Counts

Total and differential leukocyte counts were made for the purpose of detecting possible reaction to the surgical procedure employed in genetic cesareans.

Blood was collected immediately prior to surgery ("0" hour) and at twenty-four hour intervals following surgery when possible.

Table 25 represents the results of twenty-nine leukocyte counts on nonsyndactylous females and thirteen leukoctye counts on syndactylous females examined at "0" hour. Schalm's (1961) leukocyte reading for purebred

Holstein females is included for comparison. Both the syndactylous and nonsyndactylous group exhibit higher leukocyte counts per/cmm. than those recorded by Schalm. Different leukocyte counts in groups of cattle or in individuals are known to occur quite frequently, (Schalm, 1961).

Table 25. Comparison of leukocyte counts syndactylous, nonsyndactylous, and mature Holstein females (Schalm, 1961).

Bovine	No. Ct.	W.B.C. /cmm.	Neut.	Lymph.	Mono.	Eos.	Baso.
Non-syndactylous	29	11,681	27	67	1	4	1
Syndactylous	12	13,567	28	65	2	4	-
Holstein	13	7,840	32.5	54.3	5.7	5.2	0.6

Table 26 is presented to show an unusually high lymphocyte count in an apparently physically typical syndactylous female. This phenomenon has been observed in other syndactylous cattle.

Leukocyte response to surgery in syndactylous and nonsyndactylous females is indicated in Tables 27 and 28.

Table 26. Leukocyte response to surgery in syndactylous female 57B.

Hour	No. Ct.	W.B.C. /cmm.	Neutrophils Band	Neutrophils Mature	Lymph.	Mono.	Eos.	Baso.*
0	4	17,975	.5	18.5	76	1	4	-
24	4	19,912	1	30	64	1	5	-
48	1	19,000	.5	20.5	73	0	6	-
72	2	20,000	0	19	77	2	2	-

*Number of basophils was minor and considered insignificant.

Table 27. Leukocyte response to surgery in five syndactylous females.

Hour	No. Ct.	W.B.C. /cmm.	Neutrophils Band	Mature	Lymph.	Mono.	Eos.	Baso.
0	12	13,567	-*	28	65	2	4	1
24	10	17,385	-	45	48	2	5	-
48	7	18,167	-	32	55	2	11	-
72	3	14,257	-	23	73	2	2	-

*Number of immature neutrophils below 0.5 per cent and considered insignificant.

Table 28. Leukocyte response to surgery in seven nonsyndactylous females.

Hour	No. Ct.	W.B.C. /cmm.	Neutrophils Band	Mature	Lymph.	Mono.	Eos.	Baso.
0	26	11,681	-	27	67	1	4	1
24	20	13,199	-	42	53	1	3	1
48	11	14,055	-	29	64	2	4	1
72	4	9,246	-	23	67	2.5	7	.5

As the summary of leukocyte counts in Tables 27 and 28 indicates, there is a slight increase in neutrophils for the twenty-four to forty-eight hour period with a return to normal by seventy-two hours. There apparently was no significant difference in response to surgery between the syndactylous and nonsyndactylous groups.

Tables 29, 30, and 31 are included to indicate the leukocyte response to surgery of females 30B, 49B, and 54B which had six, five, and five operations respectively.

Table 29. Leukocyte response to six cesarean sections in 30B.*

Hour	No. Ct.	W.B.C. /cmm.	Neutrophils Band	Mature	Lymph.	Mono.	Eos.	Baso.
0	5	9,300	–	33**	58	0	8	–
				3,069***	5,394	–	744	
24	4	11,885	2	47	44	.5	5.5	–
			238	5,586	5,229	29	653	
48	2	10,450	2	33	54	3.5	7	–
			209	3,450	5,643	365	731	
72	2	10,275	–	28	55	6	11	–
				2,877	5,651	617	1,130	
96	1	8,800	–	17	71	1	11	–
				1,496	6,248	88	968	

*Bases on 100 cells.

**Differential percentage.

***Absolute count.

Note: All differential percentages are figured to the nearest ± .25%.

Table 30. Leukocyte response to five cesarean sections in 49B.

Hour	No. Ct.	W.B.C. /cmm.	Neutrophils Band	Mature	Lymph.	Mono.	Eos.	Baso.
0	5	18,480	–	20	76	1.5	3	–
				3,698	14,045	277	554	
24	3	19,766	1	29	64	2	2.5	–
			198	5,721	12,650	395	494	
48	3	18,650	–	20	71	2	5.5	–
				3,916	13,241	373	1,025	

Table 31. Leukocyte response to five cesarean sections in 54B.

Hour	No. Ct.	W.B.C. /cmm.	Neutrophils Band	Neutrophils Mature	Lymph.	Mono.	Eos.	Baso.
0	5	11,740	-	18 2,113	74 8,688	3.5 410	4.5 528	-
24	1	12,750	-	47 5,993	52 6,630	0	1 128	-
48	3	13,250	-	30 4,108	63 8,348	1 133	5 663	-
72	1	9,900	-	19 1,881	69 6,831	5 495	7 693	-

Cow 30B normally ran a lower total leukocyte count than 49B and neither showed any significant change from the first operation to the last. This was not true in the case of 54B. There was a progressive increase in total leukocytes from the first to the fifth operation. This may be related to the amount of omental adhesions following surgery, although at slaughter, no abscess formation or active peritonitis could be demonstrated.

In general, it could be concluded that the tissue reaction as measured by total and differential leukocyte counts was insignificant. Tissue damage is apparently mild with little infectious response noted.

Rectal Temperatures

Although body temperatures were recorded, in no case was a rise of over 1.0°F. noted following surgery. For this reason, the body temperatures are not included in this report. The lack of increase of body temperatures correlates very closely to the slight response of total leukocytes.

SUMMARY

A new method is described for facilitating the study of anomalies in the bovine.

Twelve cows of various genetic background were subjected to repeat cesarean sections at approximately forty days of pregnancy.

Seven of the females had a nonsyndactylous appearance, although two of the group, namely 30B and 77B were considered carriers of syndactylism.

Five of the females were syndactylous and exhibited varying degrees of syndactylism.

The seven nonsyndactylous females produced an average of 3.57 embryos or fetuses per cow in the first cow-year.

The five syndactylous females produced an average of 1.8 embryos or fetuses in the first cow-year.

The average breeding interval between the first cesarean section and subsequent conception was approximately forty-three days in the seven nonsyndactylous females. In general, increased breeding interval time was recorded in succeeding operations.

The average breeding interval between the first cesarean sections and subsequent conception was approximately 102 days in the five syndactylous females. The succeeding breeding intervals increased over the first as in the nonsyndactylous females.

A comparison between the average breeding intervals of the nonsyndactylous females and the syndactylous females indicated a shorter interval in favor of the nonsyndactylous. This corresponds to data furnished by Huston (1961) on the natural breeding habits of syndactylous females.

The ratio of right horn pregnancies to left horn pregnancies was fifty-five per cent to forty-five per cent.

Total and differential leukocyte counts of the group of twelve females taken immediately prior to surgery, indicated that the five syndactylous cows averaged slightly higher total leukocyte counts per/cmm. of blood than the average of the seven nonsyndactylous.

Temperature reactions were insignificant following surgery.

Gross examination of the genital tract of five slaughtered females indicated a marked surface trauma of the uterine horn as a result of the uterine forceps used in the surgical procedure. Tissue scars due to the incising of the uterine horn were slight. Apparently, neither tissue damage inflicted by the uterine forceps nor the incising interfered with subsequent conception. There appeared to be a more visible reaction to those incisions that were sutured than to those not sutured.

Tissue reaction in the paralumbar region along with vascularity increased with succeeding operations.

Limitations in this particular genetic cesarean procedure appear to be primarily instrumentation trauma of the uterine horn and paralumbar tissue reaction. Both of these reactions may possibly be overcome to some degree by advanced instrumentation and surgical techniques.

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APPENDIX

EXPLANATION OF PLATE I

Fig. 1. A close view of the procedure in which the embryo is expressed from the uterine horn.

Fig. 2. A forty-five day embryo.

PLATE I

Fig. 1

Fig. 2

BOVINE REPEAT CESAREANS AS A GENETIC AND EMBRYOLOGICAL RESEARCH TOOL

by

JOHN LEROY NOORDSY

B.S., South Dakota State College, 1944
D.V.M., Kansas State University, 1946

AN ABSTRACT OF A MASTER'S THESIS

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KANSAS STATE UNIVERSITY
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Cesarean section has been used extensively in the field of both human and veterinary medicine to relieve dystocia. Pre-terminal pregnancy cesarean sections have been used primarily in the case of impending dystocias and are relatively rare in veterinary medicine.

Genetic study of the bovine anomalies has been limited in the past by the relatively long gestation period of the bovine as compared to laboratory animals.

The procedure of early removal of the embryo from its dam by the cesarean section was undertaken with the possibility that this same dam might be rebred shortly and possibly produce more embryos in a year than the normally expected one calf.

Twelve females of varying genetic background including five that exhibited syndactylism were used in the study. The seven nonsyndactylous females had other physical defects which may or may not be considered inheritable.

Embryos and fetuses were removed from the pregnant horn at various stages of early pregnancy, but for the most part, an approximate forty day embryo was desired. Embryos at this stage exhibited the anatomical deviations.

The surgical procedure described entailed a paralumbar incision and incising of the pregnant uterine horn with subsequent expression and recovery of the embryo or fetus.

Thirty-four cesarean sections were performed on the twelve females in the first cow-year. Four nonsyndactylous cows produced four embryos or fetuses each the first year.

The seven nonsyndactylous females produced an average of 3.57 embryos

or fetuses for the first cow-year, while the five syndactylous females produced an average of 1.8 embryos or fetuses for the first cow-year.

Leukocyte determinations were used to check possible tissue reactions to the surgery. Blood collected just prior to surgery and examined for leukocyte count formed the so-called base count. Determinations were made at twenty-four hour intervals following surgery to determine reactions. The leukocyte determinations at these periods indicated a very mild increase in total leukocytes with a slight "shift to the left". A return to normal was usual in forty-eight to seventy-two hours.

Temperature readings at twenty-four hour periods following surgery were insignificant.

Limitations in the surgical procedure appeared to be the paralumbar tissue reactions and uterine trauma followed by periuterine and omental adhesions. It is hypothesized that both of these conditions could be alleviated by advanced techniques.